COPPER-PLATE RESTORATION FOR CHARTS OF SPANISH HYDROGRAPHIC INSTITUTE

by

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Cartography Sub-Section, Cadiz, 15th December 1949.

GENERAL.

In August, 1947, the Spanish Hydrographic Institute's Chart Catalogue listed 279 currently published charts.

The total number of original plates in use consisted of 269 engraved on electrolytic copper and 10 others traced on paper for reproduction by photozincography.

On 18th August of the same year occurred the explosion which totally destroyed the Institute building and it was feared that these originals, which were the result of years of painstaking and costly effort, and the Centre's most valued documentary contribution, might be irretrievably lost.

Inspection of the premises where the plates had been stored was not particularly encouraging, as the wooden cabinets containing them had been destroyed and were covered with debris ; the plates were scattered on the ground among piles of stones, pieces of wood and iron, etc. which scratched the copper originals at the slightest contact and rendered them unfit for immediate use, and caused the photozincographic originals to tear and the drawings to be defaced.

The only possible solution for the moment was to salvage what remained of the originals from the ruins, with the idea of examining them later in order to obtain an accurate opinion regarding the extent of the accident.

The originals were harmed in the process, as they were affected by any slight shifting of the rubbish on top of them ; this, however, was unavoidable, as any spot suspected of containing anything of interest could only be reached by walking over the debris.

All the copper plates were recovered, some of which had assumed the peculiar shapes shown in Figures 1, 2, and 3 ; and 8 photozincography originals were saved.

After this first encouraging phase, since actual losses were limited to two, the second phase was considered, consisting of the study and classification of damage to the original plates.

The condition of the copper plates caused particular concern. They were so vulnerable to the harder substances that covered them over that notwithstanding the recovery of the photozincographic originals, the whole chart output of the Hydrographic Institute seemed to be at stake.

Charts on hand reproduced from photozincographic originals, moreover, were more numerous than copper plate reproductions, as under normal conditions 30 prints could be obtained from a zincographic original to one engraving from a copper plate. More time was therefore available for remaking a zincographic original or in case of superficial damage for repairing the old one.

The problem consequently applied for all practical purposes to the copper plates alone since no measures of any great significance had to be taken with regard to the photozincographic plates.

Restoration of Copper-plate Originals. Appraising of Damage and Classifying of Plates.

After close examination of the copper-plates, initial fears as to their condition were borne out ; every plate showed damage to some extent and none could be used for

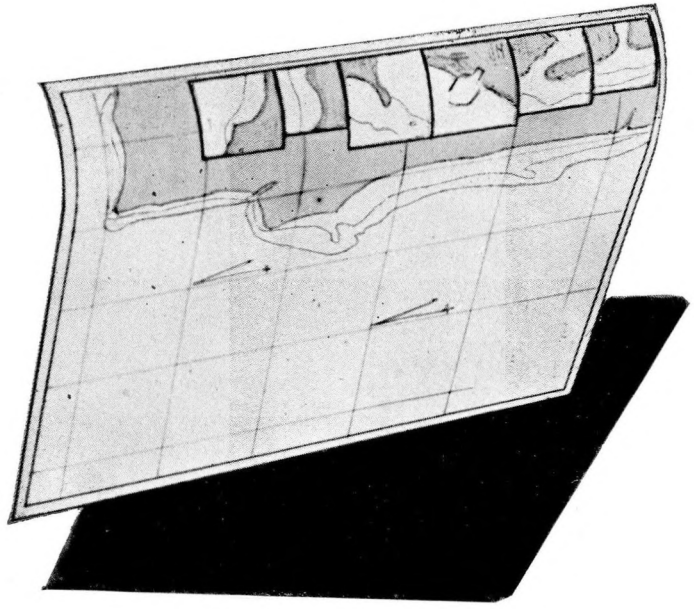

FIG. 1.

Plancha Nº 703 A
Costa W. de la Peninsula Iberica

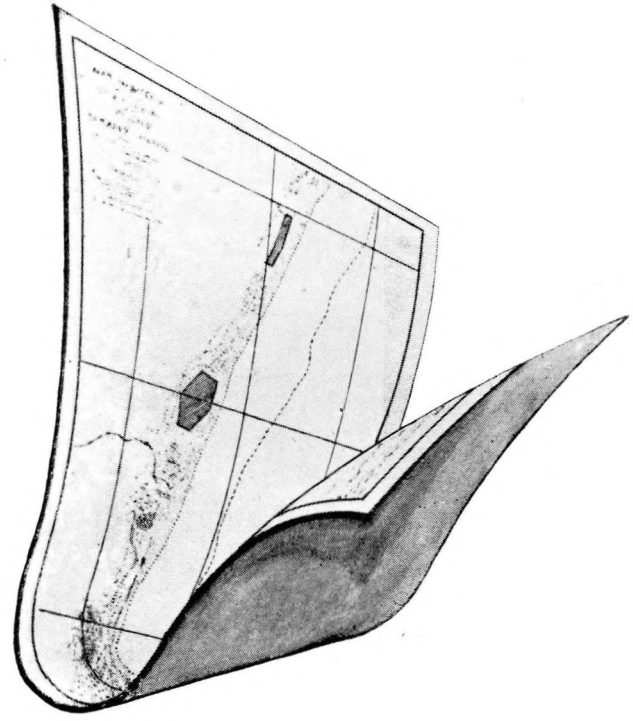

FIG. 2.

Plancha Nº 79
Fondeadero de Fuengirola

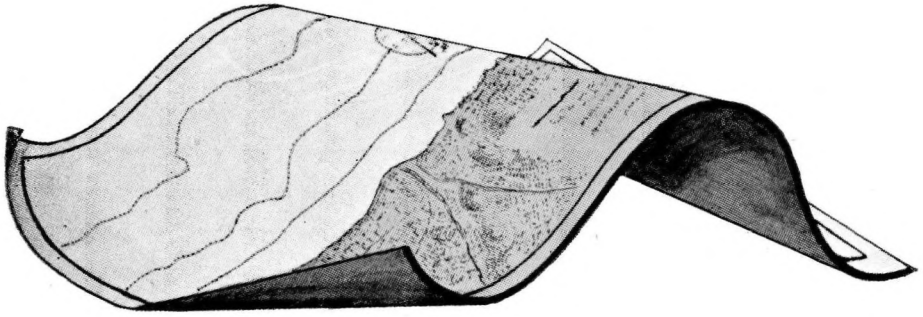

FIG. 3.

Plancha Nº 176

Fondeaderos de Villanueva y Geltru y de Sitges

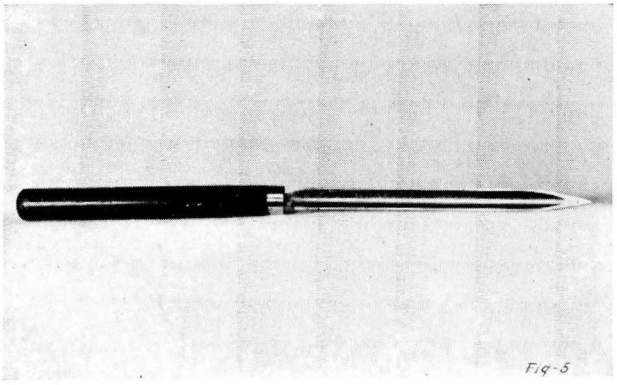

FIG. 5. — The Scraper.

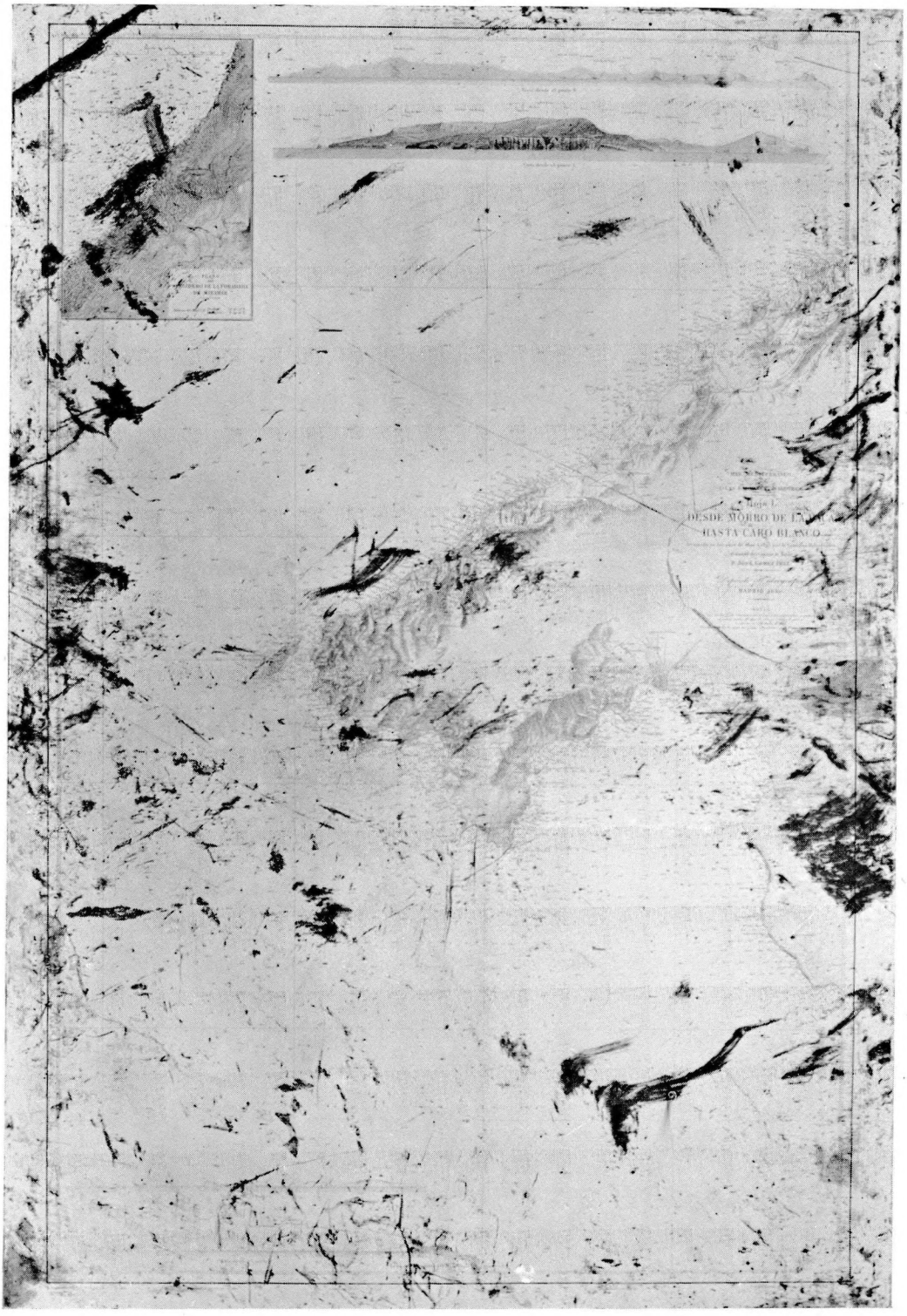

FIG. 4.


MAR MEDITERRANEO
ISLAS BALEARES — MALLORCA
Hoja 1.
DESDE MORRO DE LA VACA
HASTA CABO BLANCO
Depósito Hidrográfico
MADRID 1880
BAHIA DE CALMA

FIG. 6.

engraving purposes. After a decision had been reached as to the amount of time required to re-condition each one, they were divided into three categories :

a) Slightly damaged ; *b*) Fairly damaged ; *c*) Severely damaged.

The slightly damaged group included plates showing superficial scratches that could easily be removed by lightly polishing them with powdered charcoal, and that only slightly affected the engraved portions, particularly the areas used for navigation. About 40 % of the plates were in this group.

The fairly damaged category consisted of plates with deeper scratches requiring more extensive correction but where navigable areas were still not considerably affected. Scratches only would require removal, while the engraved portions for the time being would need no retouching ; any possible insertions could be made at a later date in less rushed circumstances. This group also included plates that had suffered a few deep scratches in the navigable zones, but where the amount of time and work required for repair would be the same. About 35 % belonged to this class.

The remainder of the plates were in the severely damaged group. Scratches were extremely deep, and in some cases the plates were perforated ; in others, while there were no scratches of very great depth, navigable areas were completely spoiled ; still others were in a considerably warped condition. This category included 25 % of the plates.

Available means for repair.

Repair of the plates required a large and carefully selected staff, divided into three specialized groups according to the type of work involved :

a) Assignment of work ;

b) Preparing of copper-plates for engraving purposes ;

c) Engraving of obliterated or weakened portions.

Work assignment was supervised by the head office of the Cartography-Sub-section, assisted by a cartographer.

The preparation of the plates for engraving purposes was entrusted to the members of the staff specializing in erasing work and the engraving itself to engravers.

It was realized that in practice necessities could hardly be met as regards both choice and number of personnel, as recourse could only be had to the Hydrographic Institute staff to make up the three required groups of specialists, and the Institute had of course made no provision for the amount of work the accident involved.

The condition of the plates required the utmost skill and patience on the part of the erasing specialists ; a single plate had to be rubbed with (linden-tree) charcoal for days, and furrows had to be dug in the plates to even out the deeper scratches, which in some cases numbered over 100 and in one instance nearly 300.

This type of work could only be carried out by a highly experienced staff, as a careless or unskilled eraser would have added to the damage rather than corrected it, which would have necessitated more time for completion of the work.

The erasing group was therefore made up of two permanent members of the staff assisted by three temporary employees who prepared the ground for the first two by removing the burrs from the deeper furrows, repairing grooves and cleaning the plates.

The actual engraving, which in the case of chart work requires infinite care, accuracy, and sharpness of line, had to be done by trained and experienced specialists ; it could not be entrusted to any ordinary professional engraver possibly not accustomed to such exacting work.

Among the six engravers of the Institute's staff were two specialists in topography, two in topography and lettering, another in lettering only, and the remaining one in mechanical engraving. All of these men were given the job of replacing the obliterated engraved portions.

As soon as temporary quarters could be found and a minimum of essential equipment collected, the staff composing the three above-mentioned groups undertook the task of restoring the plates with all possible speed.

Primary considerations in restoring process.

If all the plates had had the same degree of usefulness with regard to navigation, it would have been a simple matter to draw up a few working rules : the least damaged plates would have been taken care of first and the most severely affected plates last. But as in all Hydrographic Offices, some chart editions were of more value and use in navigation than others, falling roughly into three classifications : those that were not very necessary. those that were fairly necessary, and urgently necessary ones.

On this basis, a flexible plan had to be devised in which both the factors of importance of the chart and damage suffered by the plate would be taken into account.

Preparations were accordingly made for engraving from the important plates which were only slightly defective, with the object of giving the engravers something to work on right away and of meeting more urgent navigational needs.

While engravers were thus supplied with work for some time the erasers applied themselves to the task of preparing a set of important plates that had been more severely damaged so that they might be ready for engraving as soon as the first lot was restored.

The erasing section would then have the opportunity of dealing with plates that, aside from their importance for navigation purposes, showed only minor defects and could be prepared with little trouble in a short time ; some of the scratches were light and the engraved portions intact, so that they needed no attention on the part of the engravers and engraved copies could be made from them after they had been burnished with steel and polished with charcoal.

Plates in less favorable condition were referred, after preparation by the erasers, to the engravers during the periods elapsing between the drawing of proofs from, and the revising of, the more important plates being restored ; it was necessary to proceed in this way in order that they might be ready for printing according to the type of repairs made.

This system was easier on the engravers, as they were hardly in a position to continue working on jobs of a highly exacting nature, if they were to be expected to complete a difficult and protracted task conscientiously. The speed, accuracy and clarity of execution required considerably affected their physical condition.

The system's effect on the morale of the personnel was salutary, as they had been discouraged by the enormous number of plates requiring repairs and by the fact that no stocks were on hand in the Sales Depot. Although the plates concerned were perhaps of minor importance, spirits revived as their numbers decreased and it was realized that the end was in sight of a job that had proved difficult and had prevented attention being paid to other important activities such as the revision of published charts and the compilation of new ones.

As a general rule this triple cycle occurred regularly during the whole restoration process, with of course exceptions when requests from navigators or maritime organizations had to be complied with.

Detailed Process in Copper-Plate Restoration. Preliminary Remarks.

Copper plate No. 970 has been selected as subject in the study of restoring processes as representing an average example of the severely damaged group (deep furrows, holes, defacing of navigation areas, and extensive warping).

This particular plate had been stored, together with 53 others of the same size, in the upper part of one of the massive wooden filing cabinets ; the lower part had contained approximately 50 smaller ones, and the cabinet itself was one of three of equal size in the erasing and engraving room.

The cabinets had fallen into the cellar under the printing shop ; they weighed about 1,200 kgs, had landed on hard ground four metres down, and their destruction was complete.

The force of the explosion and violent contact with the ground, and the consequent dispersal of the shelves (which finally came to rest on a bed of rubble while fragments of stone and iron rained down upon them from the upper floors) were more than sufficient reason for the warping as shown in Figs. 1, 2 and 3, as well as for the scraping previously described.

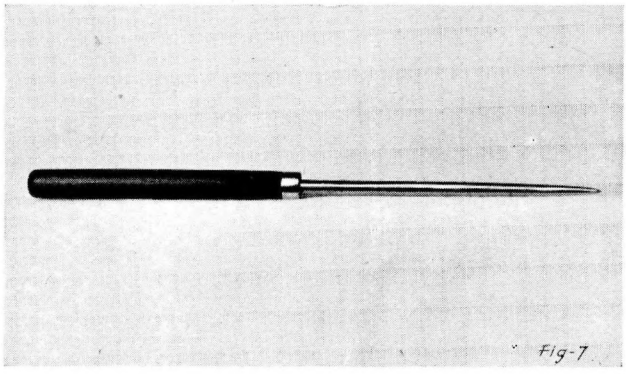

FIG. 7. — The straight steel burnisher.

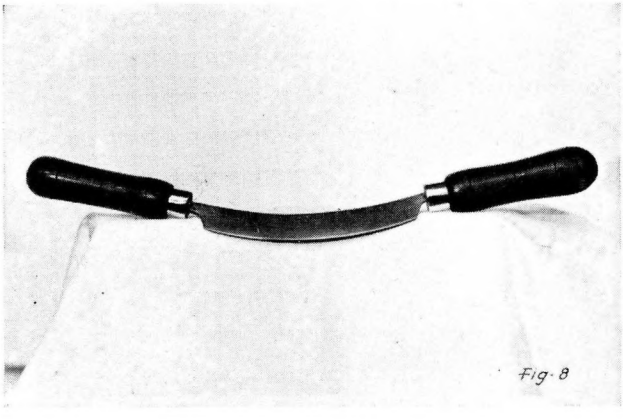

FIG. 8. — The curved burnisher.

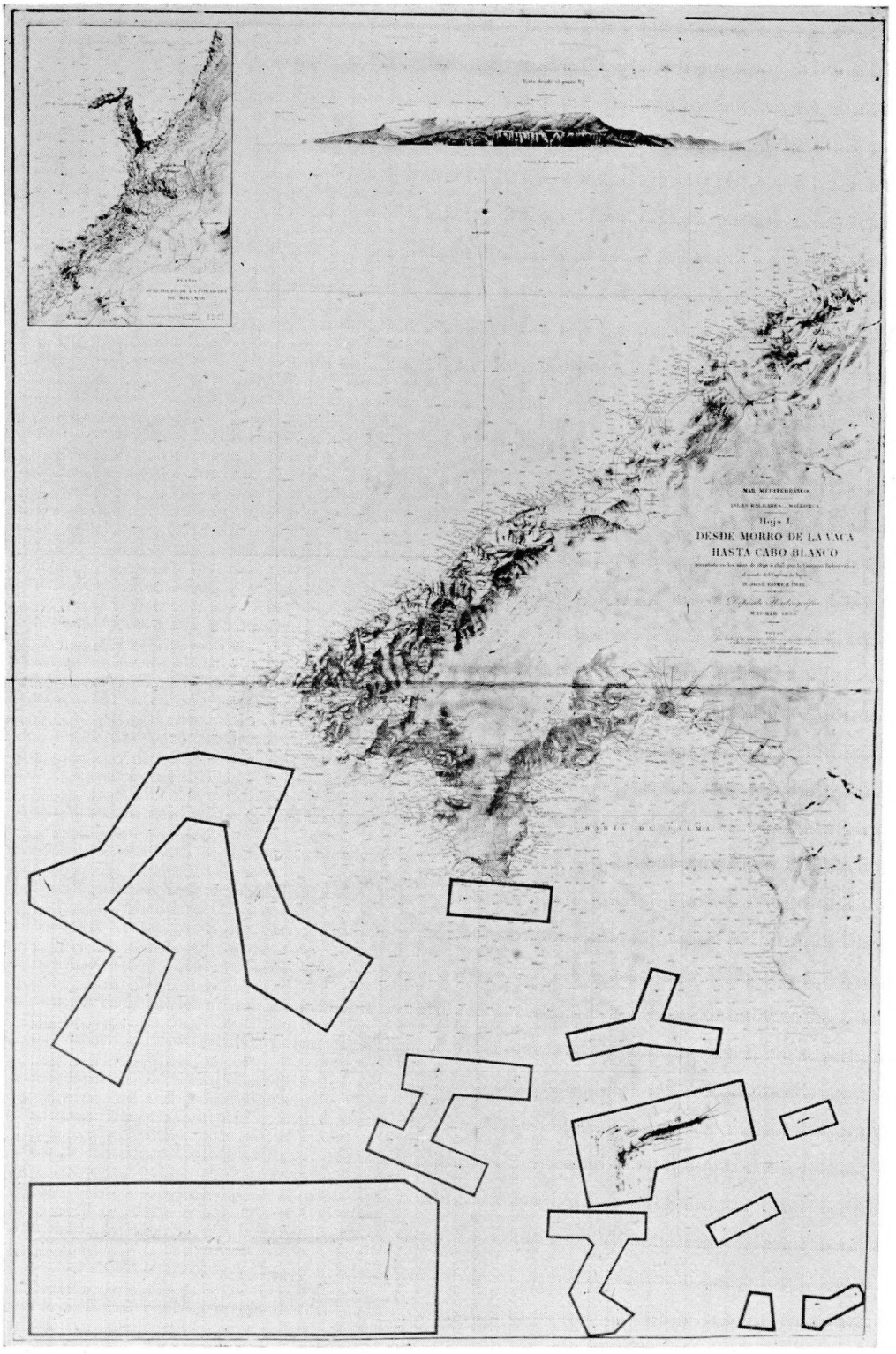
MAR MEDITERRANEO
Hoja 1.
DESDE MORRO DE LA VACA
HASTA CABO BLANCO

FIG. 9

Plate No. 970 was 1,025 cms. long, 695 cms. wide, and 2.5 mm. thick ; a chart of the western coast of Majorca from *Morro de la Vaca* to *Cabo Blanco* was engraved upon it, and it included four coastal views and an inset showing Foradada de Miramar anchorage.

It was noticed that the plate was neither perforated nor warped, and a trial proof showed the condition represented in Fig. 4 — which is a photograph of the initial proof on paper.

Examination of Damage.

As one is aware, the slightest burr left unpolished by the engraver shows up clearly on the proof as the ink cannot be removed when rubbed by tampons dipped in the various potassium solutions. An indistinct print and a black spot occur showing a poorly finished engraving.

Examination of Figure 4 leaves no room for doubt as to causes producing the dark spots on the proof ; they are the result of burrs on the engraved surface of the plate, not made, however, by a graver guided by any conscious hand, but by fragments of stone and metal. No portion has been left intact, especially the lower and side margins, and lower half of the plate. There is a dark spot indicating the presence of burrs beside gouges of varying depth and width, and in order to get a complete picture of the situation, the head office of the Sub-Section had the erasers eliminate the burrs by the following process, called *Rough Erasure Phase.*

Rough Erasure Phase.

The methods and tools used in eliminating protruding portions of the plate were as follows.

Equipment consisted of a steel scraper and linden-tree charcoal, both essential in the acquisition of a smooth finish. With the scraper (Fig. 5) the burrs could be smoothed out quickly with no great trouble apart from keeping within the damaged areas so as not to rub out the neighbouring unaffected sections, and avoiding too close a scraping of the upper surface which would result in a widening and deepening of the grooves.

Both of these problems were solved by leaving off using the scraper before the burr entirely disappeared; as the upper surface of the plate was approached, recourse was had to charcoal.

In the use of charcoal, account should be taken of experience acquired by specialists in scraping operations and the upkeep of plates. Great care must be exercised in selecting the most suitable type, owing to the varying nature of the material. Quality depends upon the kind of wood used, its degree of moisture, thickness, and carbonization ; each piece of charcoal must be subjected to several tests before it can be properly used. Experience acquired speeds up the work considerably : the right kind of piece is invariably selected, no scratching occurs during the final polishing process, and no time is lost by using a piece suitable for polishing but too soft to remove a burr.

Even if the two conditions restricting the use of the steel scraper had not existed, it would have been necessary to use the linden-tree charcoal for polishing, as the scraper, no matter how sharp it is, leaves marks on the copper.

After 70 hours of treatment by these methods, the first erasing phase was considered as being over, and the proof represented by Fig. 6 was obtained (photograph of paper-proof). Compared with Fig. 4 it is far less confused. Practically all the large spots have disappeared, leaving the background much clearer and enabling each scratch to be classified and elimination methods to be determined.

It may be noticed that in topographic areas and outside the scaled borders, burrs were dealt with in superficial fashion. This was in order to use the aptitudes of the personnel available to the best possible advantage, with due consideration for time and place of application.

Burrs occurring in topographic zones required the greatest skill and ability, as any slight error would necessitate more work on the part of the engravers ; besides, the area concerned in this case was particularly difficult.

Those appearing on the outside borders could be entrusted to less skilled operators, as no possible error would require lengthy repairs.

The head-office, with due regard for personnel distribution and the over-all restoration programme, designated this latter operation as *Border Conditioning*.

Border Conditioning Phase.

No real difficulty was encountered in this phase, as apart from the border grooves themselves no engraved areas appear on the plate. As the border grooves are deeply etched, there was no risk of their being easily removed unless deep scratches appeared upon them or in their immediate vicinity ; and even if they did disappear, they could be replaced with ease.

Equipment used consisted of a steel scraper, emery paper, two steel burnishers (one straight and the other curved) and linden-tree charcoal.

The steel scraper was used to remove the larger burrs and the emery paper then applied to level the plate surface outside the borders.

Even the finest emery paper scratches, and charcoal was therefore utilized as a polishing agent.

All scratches are not eliminated after the described treatment. The deeper ones persist, although largely reduced, as the sole purpose in using the emery paper is to smooth the plate down to its approximately original level, or else the level where most of the lighter scratches disappear ; the latter are generally more numerous and their prevalence causes no great damage, excessive amount of work or delay.

Complete elimination is achieved by pushing the surrounding copper into the scratch with the straight steel burnisher (Fig. 7), by means of a quick rubbing motion of the slightly curved bevel end. The cracks are filled in with a consequent slight lowering of the surrounding surface.

When the scratches are at some distance away from the border grooves, there is no danger of the engraved portion's disappearance and in such cases use of the curved burnisher (Fig. 8) is recommended ; quicker results can be obtained, as it is easier to handle, covers a wider surface, and can be operated with both hands, supplying heavier pressure.

If some of the scratches in the area considered should be unusually deep, neither burnisher should be used as too great a lowering of the surface would be obtained. Under these circumstances another method is used, not, however, by the same operators, but by a more experienced group in a later phase.

After the burnishing treatment comes an essential charcoal polishing process for removal of the slight scratches made by the burnishers ; the plates are then in condition.

It took 32 hours to complete this phase in the case of Plate No. 970. Figure 9, which reproduces a proof made at that time, shows the results obtained, including breaks in the outside grooves due to the removal of scratches upon them.

Second Damage Examination.

After conditioning of the outside grooves, Plate No. 970 was ready for more delicate treatment, consisting in the removal of the last traces of damage prior to its being turned over to the engravers.

The necessity of using to the best advantage the combined skills of the staff, most of whom were new to this type of operation, and the fact that the pace had to be speeded up to keep the engravers supplied, led to a division of the final pre-engraving process into two separate phases.

The scratches inside the margins showed distinctive characteristics. Some were deep, others were of superficial character ; some were in delicate spots, and others in clearer ones. The deep scratches and those in the more crowded areas were classified in one group, and the superficial scratches and those in the clearer areas were assigned to another. The latter group would be dealt with by capable but comparatively inexperienced members of the staff, while the first would be treated by the more expert erasers.

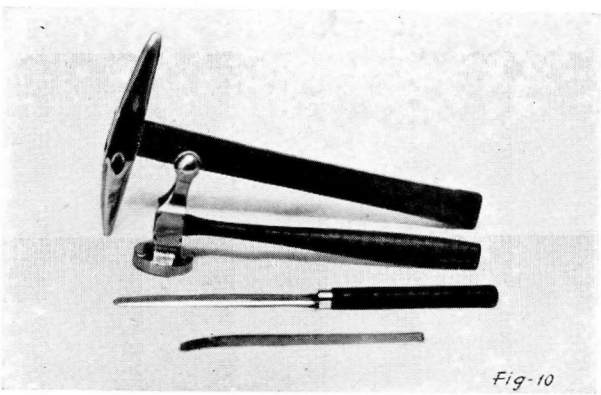

FIG. 10. — Hammers and scrapers

FIG. 11

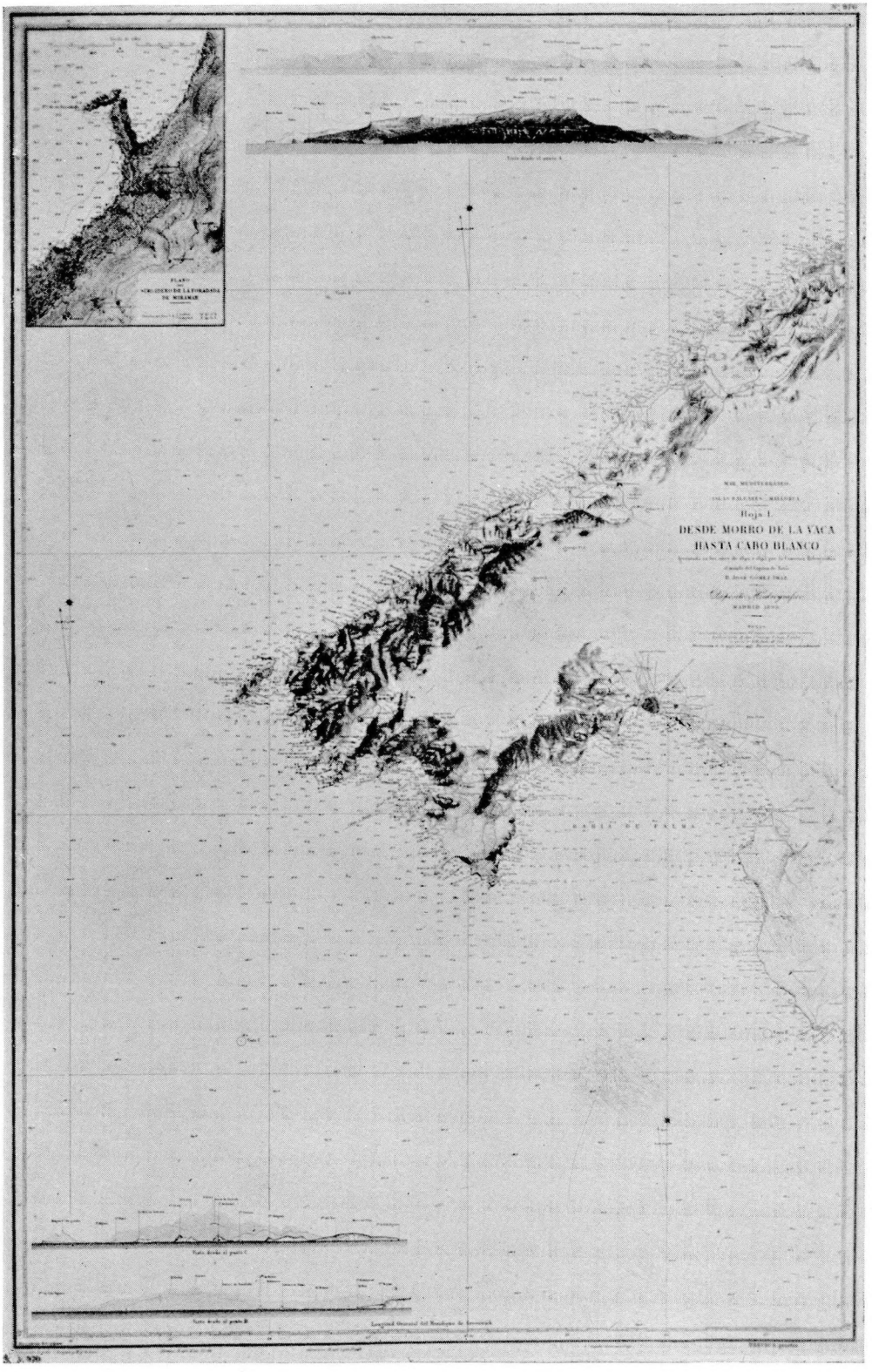
Hoja 1
DESDE MORRO DE LA YACA
HASTA CABO BLANCO
BAHIA DE PALMA

FIG. 12.

This grouping was decided upon by the head-office of the Sub-Section. Figure 9 shows the result of the examination with regard to Plate No. 970.

The defects to be corrected during the *Fine Erasing* phase are enclosed within the black lines. Defects outside these zones were entrusted for correction to less experienced employees, and the process designated as *Medium Erasing*.

Medium Erasing Phase.

68 hours were required for the completion of this phase with regard to Plate No. 970, using only the straight steel burnisher and charcoal as described in the preceding paragraphs. As a result, the scratched engraved portions were almost although not quite rubbed out entirely. Only where a scratch coincided with an engraved section did they both disappear, but owing to the grouping described above this occurred fairly infrequently. Large areas were then ready for retouching by the engravers.

Fine Erasing Phase.

In this phase, the most important and exacting part of the erasing process, three techniques were used : erasing with the straight steel burnisher, a hammering process of erasing, and charcoal polishing.

The use of the straight burnisher has already been described ; its function here was to eliminate light scratches in difficult spots on or near the engraved portions.

The hammering process consisted in opening up a furrow on the front of the plate where there was a deep scratch, in such a way as to absorb the latter completely, and in then filling it in by hammering the back of the plate. This method had to be resorted to in the case of most of the scratches surrounded by the black lines on Figure 9.

Tools employed in this process are shown in Figure 10, and were used as follows :

1 and 2 : Hammer and curved chisel for opening up furrows ;

3 : Scraper with curved ends to round out furrow edges ;

4 : Hammer for raising furrows to general plate level by hammering at appropriate spots on reverse side of the plate, after placing part affected on small steel anvil.

After burnishing and hammering, the parts repaired were polished with charcoal. 67 hours were required to obtain the print shown in Figure 11, which shows the state of the plate as handed over to the engravers.

Restoring of engraving.

Restoring the engraved portions of Plate No. 970 took 270 hours. It should be mentioned, however, that the two coastal views on the lower part of the plate had to be completely re-engraved. It had taken an extra 18 hours to erase them completely, but it would have been more trouble for the engraver to deal with what had been left originally, particularly as regards the fitting of new depth curves to the old ones.

Results of restoration.

The final proof, reproduced in Figure 12, shows a chart in perfect condition for use in navigation. There are a few scattered and superficial scratches in the land areas, which are noticeable, but since the prime objective was to restore the plates so that prints could be obtained for navigation purposes, these were left for a later stage.

A total of 525 hours of erasing and engraving were required for re-conditioning a plate considered as an average example of the severely damaged group.

Conclusions.

The numerous conclusions reached following examination and repair fall into two groups. The first set has to do with preventive measures in case of similar accidents, and the second with the most rapid and practical means of repairing possible future damage.

With reference to the first group, experience shows that the shelves should be as strong as possible ; cabinets should be made of metal and stored in cellars or on the lower floors.

In connection with the second group, the best method of repair remains open to question, as account must be taken of the methods at hand and known by experience. In our particular case, the only means available were the ones described, but we do not deny that it would have been much quicker and easier to use photographic methods either exclusively, or a combination of both. Or we could have solved the problem by making photozincographic copies, using as originals copies on sale before the accident. Each process, as we say, requires appropriate equipment and personnel.

In our opinion and as a general rule, it would be prudent to adopt a double filing system, where two sets of originals, each for reproduction by a different method, would be filed some distance apart. Copper-plate and offset methods could be used, in which case, of course, not the offset plates but the originals to be photographed would be filed.

As a last conclusion, it should be noted that the use of copper plates in printing nautical charts has the advantage of being a process of considerable lasting qualities, as attested by the fact that in spite of the vast amount of damage incurred by Hydrographic Institute sets, not one was left unrestored.